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ABSTRACT

A student-suggested project at an elementary-level mathematics laboratory using an adding machine to print a million twos is presented and described. Questions, problems, and activities that took place as the project was carried out are described. The process of producing twos presented all children with the necessity of gauging time intervals and of counting and recording large quantities of items. In addition, many children learned how to operate the adding machine: count by ones, tens, hundreds, and thousands; estimate; multiply; find an average; measure; construct a ruler; and many other things that were unforseen benefits of the project. (MP)

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# A MILLION TWOS

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# A MILLION TWOS

Why try to write a million twos?

For fun, of course. And to see how large a million is--a million twos or anything else.

Well, how large <u>is</u> a million?

<u>Twice as large as the number of twos we finally did write</u>

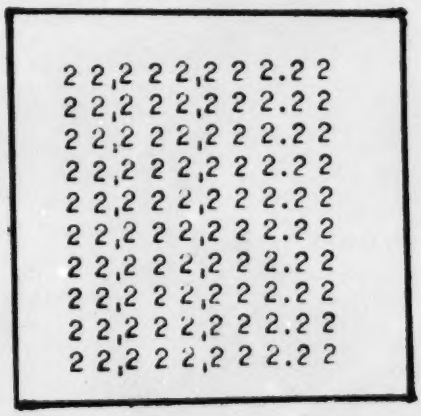
<u>Also ½ as large as the population of Philadelphia</u>

<u>$10,000 in pennies</u>

<u>a little more than eleven days' worth of seconds</u>

<u>enough drops of water to fill a small bathtub</u>

The "Million Twos Project" began in the math lab* when Bridgid joyfully displayed a strip of adding machine tape-- proof of her mastery of the machine. She had succeeded in commanding it to print nothing but twos in neat rows and columns.




One hundred 2's

*This project took place in the mathematics laboratory at the Durham Child Development Center in Philadelphia in the school year 1970-71. Lore Rasmussen, Director of the Learning Centers Project, of which the math lab is a part, originally suggested trying to demonstrate in some way how large is a million. "We" includes Joshua Bogin, an Oberlin College student who was working with me in the math lab, and who shared the labor as well as the insights of the project.

"How many twos do you think you have here?"

"More than a hundred?" "Oh, yes."

"More than a thousand?" "I don't know." We checked and it was.

"Do you think we could make a million twos?"

The answer was yes, and so we began. All the children then in the math lab were recruited, and there seemed to be nothing they enjoyed more than cranking out twos.

Using the repeat button on the machine (an Olivetti-Underwood Summa Prima 20) a child could print ten twos with a single pull of the handle (22222222.22); one hundred twos with ten pulls. This took only about ten seconds, and most children were amazed that one hundred twos could be written in such a short time. A thousand twos took one hundred pulls, which could be accomplished in less than two minutes. Again they were surprised. At this rate, they thought, it wouldn't take long to reach a million. By the end of the first afternoon, 5,050 twos had been produced.

News of the project spread like wildfire. By the next day making twos was first choice on the list of every child who visited the math lab, and soon the entire school (kindergarten through fourth grades) was busy trying to reach a million. The adding machine chattered from nine till two-thirty, setting us to wondering whether it would wear out before the magic number was arrived at. We borrowed a second machine from the office. The school's budgeting and accounting stood still while the two production mounted,

reaching a daily average of 25,000.

Adding machines had always been a popular attraction in the lab. Kindergarten and first grade children had at first been fascinated only by the mechanical operation of the machine, then intrigued to notice that some machines could count (registering the number of turns of the handle.) Watching the dial, they would count along with it, acquiring a familiarity with the sequence of numerals and the phenomenon of place value. Later they would discover that the machines could do simple arithmetic problems--addition, subtraction and multiplication. Older children had enjoyed doing a problem, then checking results by machine, or racing against the machines in computation, or trying to figure out how to make them divide. This strengthened their knowledge of arithmetical facts, but also provided insights into structure, for the mechanical processes of the machines often parallel the algorithms of arithmetic. Machines had served as cash registers in the "store" and were brought out to solve problems within the understanding but beyond the computational skills of the students.

The Olivetti had been a favorite, since it was the only machine which produced a printed tape--both a record and a souvenir to treasure. Now it had been enlisted as a printer. Of course everyone wanted to use it at once. To forestall tears and fistfights it was necessary to ration time using egg timers or, for longer intervals, watching the clock. Even so, children were disappointed at the small amount of time available to them, and notes began to arrive ("May I please come to the math lab to make some

twos?") from children who wanted to come at times other than their scheduled hours. Halfway through, the project nearly collapsed when an impatient eight-year-old threw a handful of sand into the machine. To everyone's relief he was able to restore it to operating condition with the help of a kind adult and a vacuum cleaner.

What to do with all these twos? They had to be tallied and displayed in a way which matched the drama of the project. When time permitted each child counted his own twos. At first this was done by counting the twos in each row:

"one, two, three, four, five, six, seven, eight, nine, ten,"

then counting by rows:

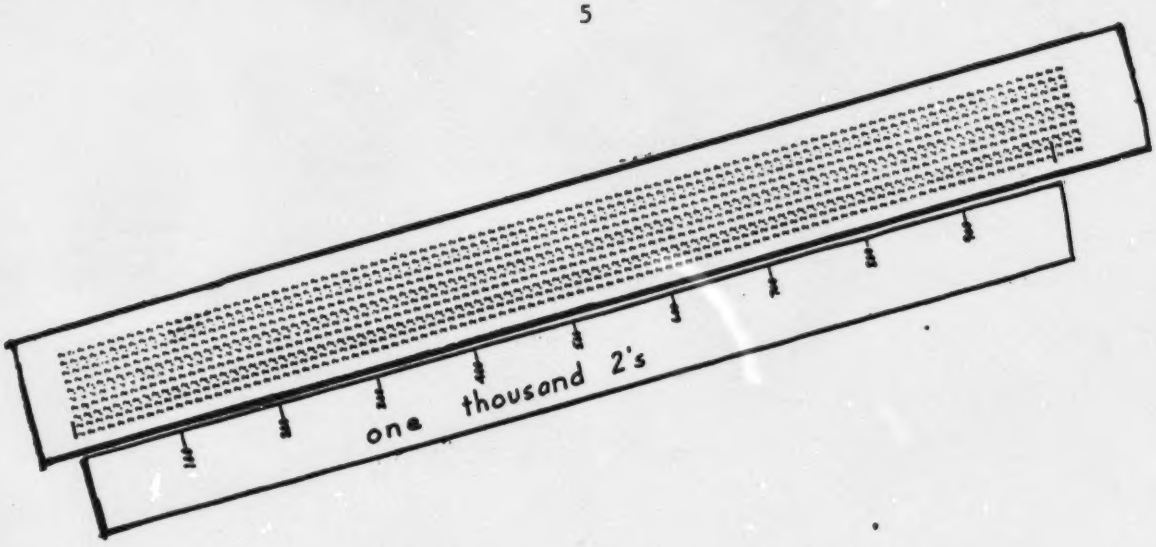
"ten, twenty, thirty, forty, fifty, sixty, seventy, eighty, ninety, one hundred,"

and finally counting by hundreds:

"one hundred, two hundred, ...nine hundred, ten hundred."

until a thousand twos were counted and marked off. The number of twos was recorded on the back of the tape along with the name of the producer to show that he had contributed this large number of twos. The adding machine was used to add up the total periodically.

When the project had been underway for a few days it became evident that a more efficient method of counting was needed. We cut a piece of oaktag the length of a strip of a thousand twos, and at the suggestion of a third grader we made this into a "ruler" by marking off hundreds.




After each child had made an initial count by tens, hundreds, etc., he was allowed to use the ruler to count his twos. Some third and fourth graders became adept at estimating the number of twos before measuring and often helped younger children to count theirs.

For display, we at first tacked the strips on poster board, but since the supply of poster board was soon outstripped we transferred to the wall above the blackboard. The total was posted below. Seen all together the display was impressive, and inspired wonder among children and adults alike.

"There must be a million already!"

"Well, are we halfway there yet?"

"Can you believe that if each two were a person we would need ten times as many to make up the whole population of Philadelphia?"

"Let's put a ring around the ones at Durham School."

When the project ended the half million twos were moved to the hallway, where they covered a wall 6½ feet high and 24 feet long.

Counting and displaying completed strips was so time-consuming that we were always behind. We usually totalled them ourselves since no child showed an interest in the task, the production itself being their primary goal. In retrospect it would have been better if each child had been required (not merely encouraged) to count his own twos, record the number on a daily tally, and attach his strip to the bottom of the previous one. A project leader could then have added the daily tally easily and could have helped to display the day's production.

Many questions arose naturally in the course of the project. Some concerned the operation of the machine and were easily settled. Others were mathematical in nature and struck at the heart of the distinction between number and numeral. Children occasionally "counted" the twos in a single row by saying "two, four, six, eight,..."[1] Others pushed the addition button on the machine to find out "how much" they had written.[2] These matters were discussed when they arose.

Games and contests developed, too.

"How many twos can you print in a minute?"

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1 Throughout the project "2" was treated as a numeral--a symbol. Any other symbol would have served as well. In counting "two, four, six, eight,.." the children were regarding the twos as numbers, and adding up their sum. If the twos had been a's or *'s no such confusion would have existed.

2 A similar confusion is revealed here. The machine adds numbers:

$$\begin{array}{r} 22222222.22 \\ \underline{22222222.22} \\ 44444444.44 \end{array}$$

so that the total does not indicate the number of twos (only 20).

"If I used two adding machines and both hands could I make twice as many twos in a minute?"

"How long does it take to print a thousand twos?"

Children challenged each other to speed races or contests to produce the longest tape. All questions and challenges were taken up. Stopwatches, wristwatches, sand timers, and the second hand on the clock became important instruments as the necessity of gauging time became obvious.

Problems of classroom management were inevitably encountered. The allotment of time and the difficulty of tallying have already been mentioned. Another unforeseen problem was that younger children often were so proud of their accomplishments that they naturally wanted to take the strip home. At first we naively allowed a child to take the tape on the understanding that he would bring it back to add to the collection. Few, of course, came back. To avoid squelching enthusiasm we then permitted them to keep the first tape or to make a strip of one thousand twos to take home. Subsequent strips were to be contributed to the project. This satisfied the children.

As the total number of twos approached 500,000 enthusiasm waned and the children's interest drifted to other things. After four weeks the chatter of adding machines rang in our ears and we, too, had had enough. A shortage of paper tape provided a practical reason for calling a halt.

As a finale we held a "Half Million Contest." First and second prizes for the first two correct answers to each contest question were an hour and a half hour respectively with the adding machine <u>all to yourself</u>. (See Appendix 1 for the questions.)

What was learned?

Certainly not the same things by every child. However the process of producing twos presented all children with the necessity of gauging time intervals, and of counting and recording large numbers of twos. Some had never before encountered numbers in the thousands, and many had never seen such a large number of things assembled in one place nor had they been able to compare visually the relative sizes of 10, 100, 1000, 10,000 etc. The array of symbols on the tape was a natural embodiment of multiplication by 10, 100, 1000. In addition the games, activities and discussions which arose in the course of the project touched on many other mathematical concepts. Although the project began with the simple goal of reaching one million, the list of mathematical benefits far exceeded this. Certainly some or all children gained skill or acquired insights into:

how to operate the adding machine

counting by ones, tens, hundreds, and thousands

numeration

writing three-and-four-digit numerals (the number of twos one had made, for example)

reading large numerals (the numeral 22222222.22, the number of twos made by others, the daily tally, the cumulative tally)

recognizing the difference between counting digits, reading the numeral, and adding the numbers represented by individual digits

telling time

reading seconds and minutes on a clock

using and reading a stopwatch

using a variety of timekeepers to gauge a minute, three minutes, five minutes, etc.

estimation (How long is a minute? How many twos on a strip, or on the wall? How many twos could be made in a given day? How long would it take to reach a million?)

multiplication

multiplying by ten, a hundred, a thousand

multiplying other numbers (the number of twos produced in a minute by a number of minutes, etc.)

averaging

measurement

selecting a unit (the length of a strip of one hundred or one thousand twos)

constructing a ruler.

We could have also introduced graphing based on records of the daily tally or the numbers of twos made by individual children on different days.

In addition to the mathematical gains, we saw encouraging progress in the ability of some children to share equipment and to work with others. Cooperation and teamwork were often spontaneous, as when older children helped younger ones to use the machine and to count twos, or when children organized teams to see how long a strip they could produce together.

Finally, we all learned, in a dramatic way, just how very large is

A MILLION.

## APPENDIX A

### Questions from the "Million Twos Contest"

For ages 5 - 7 only

1. We made one-half million twos. How many more would we have to make to reach one million?

2. There were 10 twos in each row. How many rows do you have to write to make 100 twos?

3. If Wade made 25 rows of twos and Brendan made 34 rows of twos, how many rows did they make altogether?

4. What is the numeral which means half a million? Write it.

For all ages

5. What is the sum of half a million twos?

6. There are ten twos in each row so a row looks like this:

   2222222222

   if you leave out the dot. What is the name of this numeral? Write it in words.

7. Each row of twos has a dot in it, like this: 22222222.22
   If you put a $ sign in front, what amount of money does this stand for? Write it in words.

8. How many rows of twos did we have to write to get half a million twos?

9. What is the sum of all the rows? (This question means: If we wrote half a million twos, in rows of ten without stopping, and then we pushed the "add" button on the adding machine, what numeral would it write if it had enough space?)

10. If Nick could write 980 twos in one minute, how many could he write in one hour?

11. One row of twos is about 1½ inches long. If we put all the rows end to end how long would a string of half a million twos be? (Hint: It would be more than a mile long.)

12. How large is a million?

    Twice as large as the number of twos on the wall.

    Only one third as large as the number of people who live in Philadelphia.

    11 days, 13 hours, 46 minutes, and 40 seconds, measured in seconds.

    Tell us how large a million is in another way. (Each correct answer will win an hour with the adding machine for the person who gives it.)

## APPENDIX B

If you don't have an adding machine there are many other ways to illustrate a million. Here are a few possibilities. Your imagination can supply others.

Use a typewriter. This takes ten times as much effort of course, since each symbol must be printed individually. We had started such a project earlier in the year with the goal of writing a million 0's. It collapsed, primarily because the children could not restrict themselves to writing only 0's and kept shifting the position of the paper in the carriage. A better idea might be to aim for a million letters of any sort. The margins could be set for a line of 50 or 100 letters (if you have one with a long carriage) for convenience in counting.

Use rubber stamps. Children love to stamp things. Have a stamp made with ten symbols, or a hundred if a single symbol seems too laborious. Some procedure ( e.g. inch-squared graph paper) would have to be worked out to keep the stamped symbols in an orderly arrangement so they could be counted.

Order a computer printout. Here the children do no work, so the sense of individual involvement would be lost. The entire printout could be displayed, however, and children could mark off significant numbers of symbols (the population of the school, city, etc.) as in the fascinating book One Million by Hendrik Hertzberg (Simon and Schuster, 1970).

Collect small objects. Rice, dried peas, the residue from a hole puncher would be appropriate. Count or estimate the number in a jar, or fill a container with perhaps ten thousand. Assemble enough jars to total

a million.

Gather newspapers. Estimating the number of letters on a page is an exciting project in itself. This could be done for each page, and a cumulative total kept, or an estimate could be made for one page and the number of pages needed for a million letters could be computed and assembled.

String tiny macaroni beads. This might be a lengthy procedure, but could be a project to occupy children in spare moments. Different colored beads can mark tens, hundreds, thousands, etc. A linear display of a million would be impressive.

Please return to: "Teacher to Teacher" Editor
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QUESTIONNAIRE: A MILLION TWOS

1. Would you want to use this booklet in your classroom (or with the teachers with whom you work)? If not, could you explain why?

2. How would you use this booklet? (a) Give to teachers? (b) In combination with in-service training? (c) Pre-service training? (d) Reference library? (e) Other?

3. Do you now use booklets like this? If so, how would you compare the usefulness, attractiveness, and readability of this booklet to those now available to you?

4. Are there other subject areas you would like to see covered in similar materials? (We have other teacher-writings in process which might fit your needs.)

THANK YOU FOR YOUR ATTENTION TO THIS QUESTIONNAIRE.